

Station-Based Indices for Drought Monitoring in the U.S.

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NADM Workshop

Mexico City, Mexico, October 2006

* (with graphical assistance provided by Mike Squires, Jesse Enloe)



National Climatic Data Center



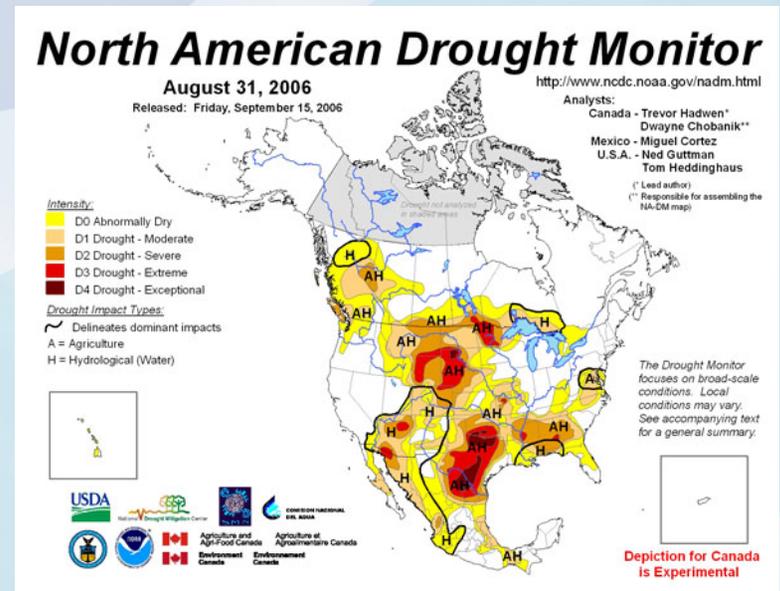
Background

- ✓ Drought monitoring in U.S. has been based on station data and climate division data
- ✓ Some drought indices require spatially and temporally complete data
 - Station data have missing months and different periods of record
 - *Climate division data have no missing data back to 1895*
- ✓ Climate division data are area-averages and provide a large-scale picture of the climate
- ✓ *Station data are point measurements and provide a finer spatial resolution*



North America Drought Monitor

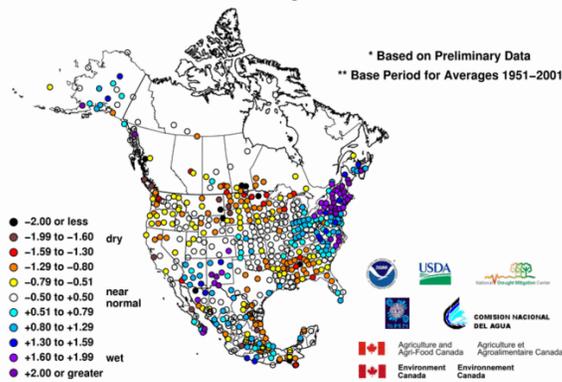
- ✓ Trilateral partnership (U.S., Mexico, Canada) to improve drought monitoring on the North American continent and provide decision makers with information essential to planning, mitigation, & response activities.
- ✓ First meeting – 11/01
- ✓ First NADM workshop – 4/02
- ✓ First exp. NADM map – 12/02
- ✓ NADM maps released to public – 4/03
- ✓ US & MX portions “operational” – 6/05



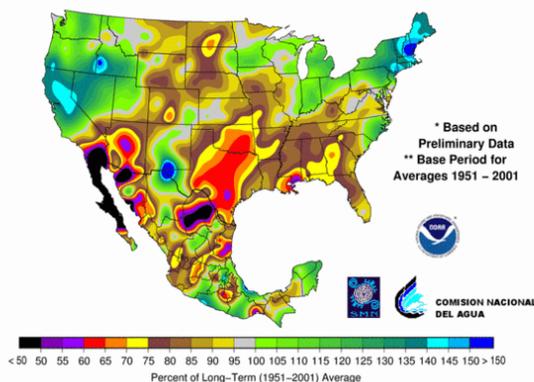
NADM Continental Drought Indicators

- ✓ Drought conditions in US, MX, CN are determined independently based on different data, indices, & analyses within each country
- ✓ Drought indices covering entire continent are needed
 - Same indices, same analysis period, same methodologies
 - This consistency needed for depiction across international boundaries

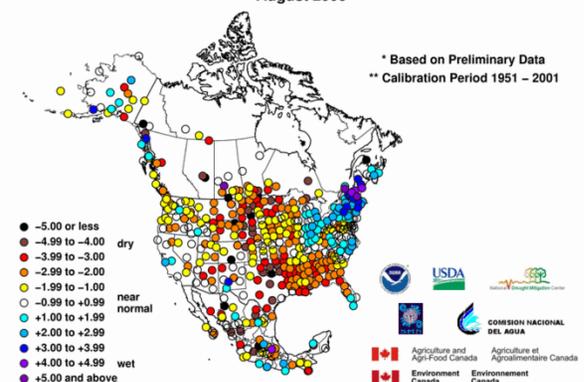
3-Month Standardized Precipitation Index
June – August 2006



Percent of Long-Term Average Precipitation, 12-Month
September 2005 – August 2006



Palmer Drought Index
August 2006



NADM Continental Drought Indicators

✓ Mexico

- Monthly precipitation from 132 highest quality stations
- Temperature from 65 high quality Observatory stations, plus 67 additional stations

✓ Canada

- Monthly precipitation and temperature from ~ 200-300 daily near-real time stations

✓ U.S.

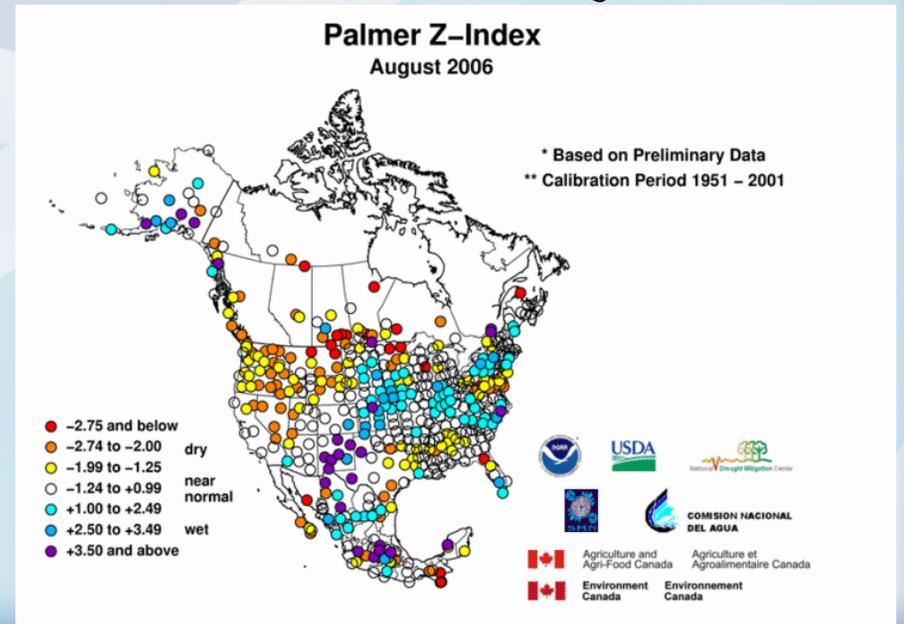
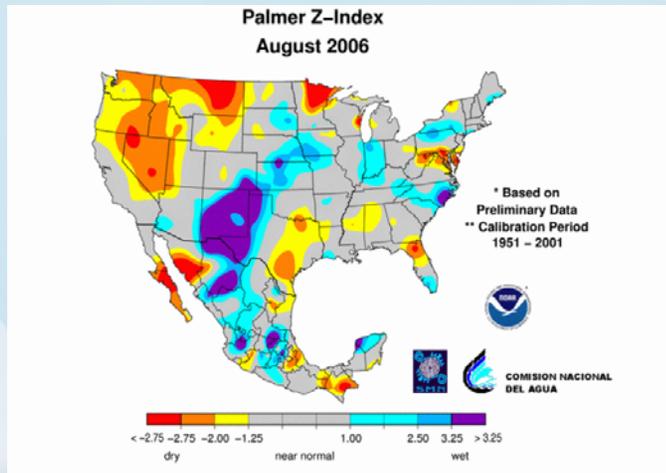
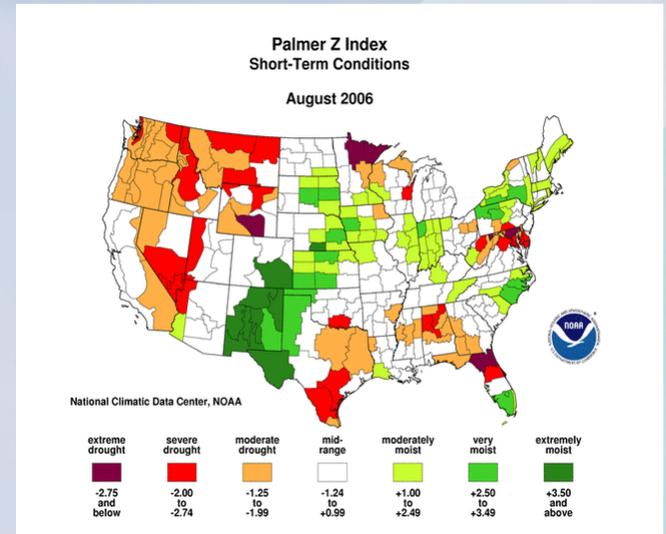
- Alaska ASOS stations & 10 COOP stations along US-MX border
- Climate division data for contiguous U.S.



U.S. Indicators

✓ The climate division data are area averages, not point measurements

- Do not have the same spatial resolution as CN & MX data
- Inhomogeneity at the international borders

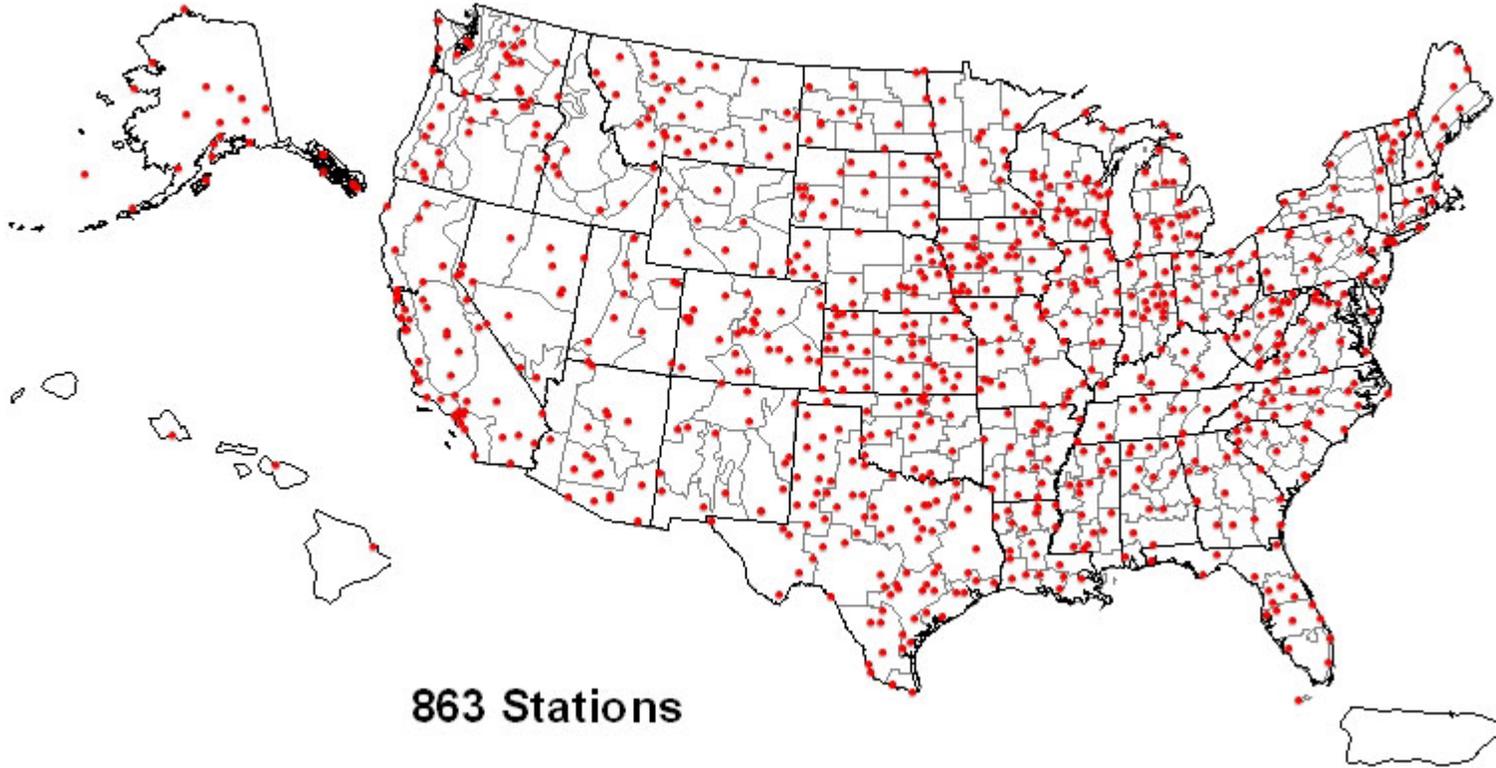


For the U.S., What Do We Do?

- ✓ **We need to transition from climate divisions to station data nationwide**
- ✓ **2159 COOP stations had both temperature and precipitation data for August 2006**
 - **1039 of them had data for August 2006, had at least 43 years of data, and were at least 85% complete for both temperature and precipitation from 1951-present**
 - **863 of them had data for September 2006, had at least 43 years of data, and were at least 85% complete for both temperature and precipitation from 1951-present**
 - **For some indicators like the Palmer index, we need to estimate the values for the missing months**
 - **For now, we used the 1951-2001 long-term means, but in the future we want to estimate by linear regression using neighboring stations**



September 2006 Stations

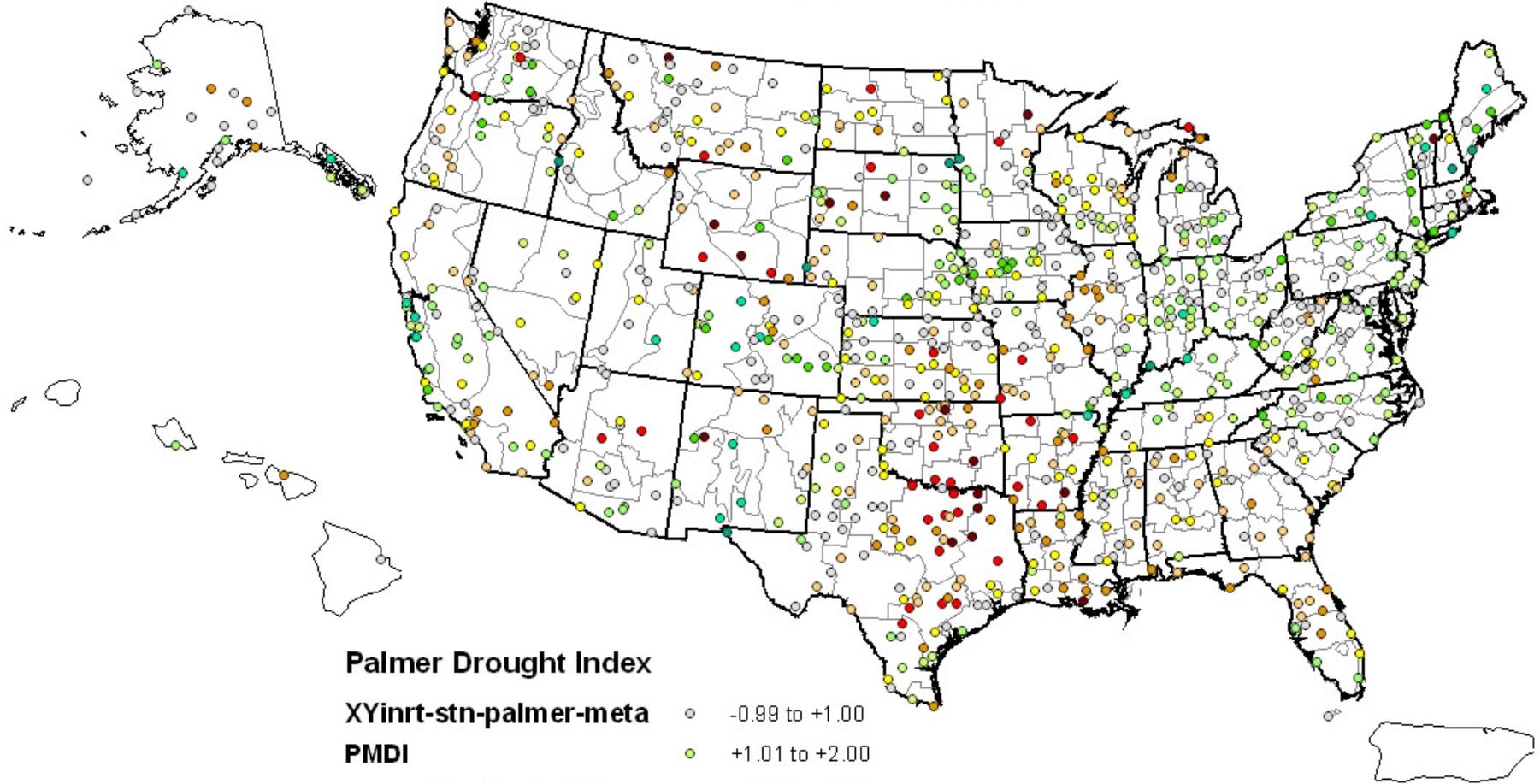


Stations with at least 43 years of data which are at least 85% complete for both temperature and precipitation for 1951-present



September 2006 Drought Conditions

863 Stations



Palmer Drought Index

XYinrt-stn-palmer-meta

PMDI

- | | |
|-----------------------|----------------------|
| ● -5.0 and below (D4) | ○ -0.99 to +1.00 |
| ● -4.99 to -4.00 (D3) | ● +1.01 to +2.00 |
| ● -3.99 to -3.00 (D2) | ● +2.01 to +3.00 |
| ● -2.99 to -2.00 (D1) | ● +3.01 to +4.00 |
| ● -1.99 to -1.00 (D0) | ● +4.01 to +5.00 |
| | ● greater than +5.00 |



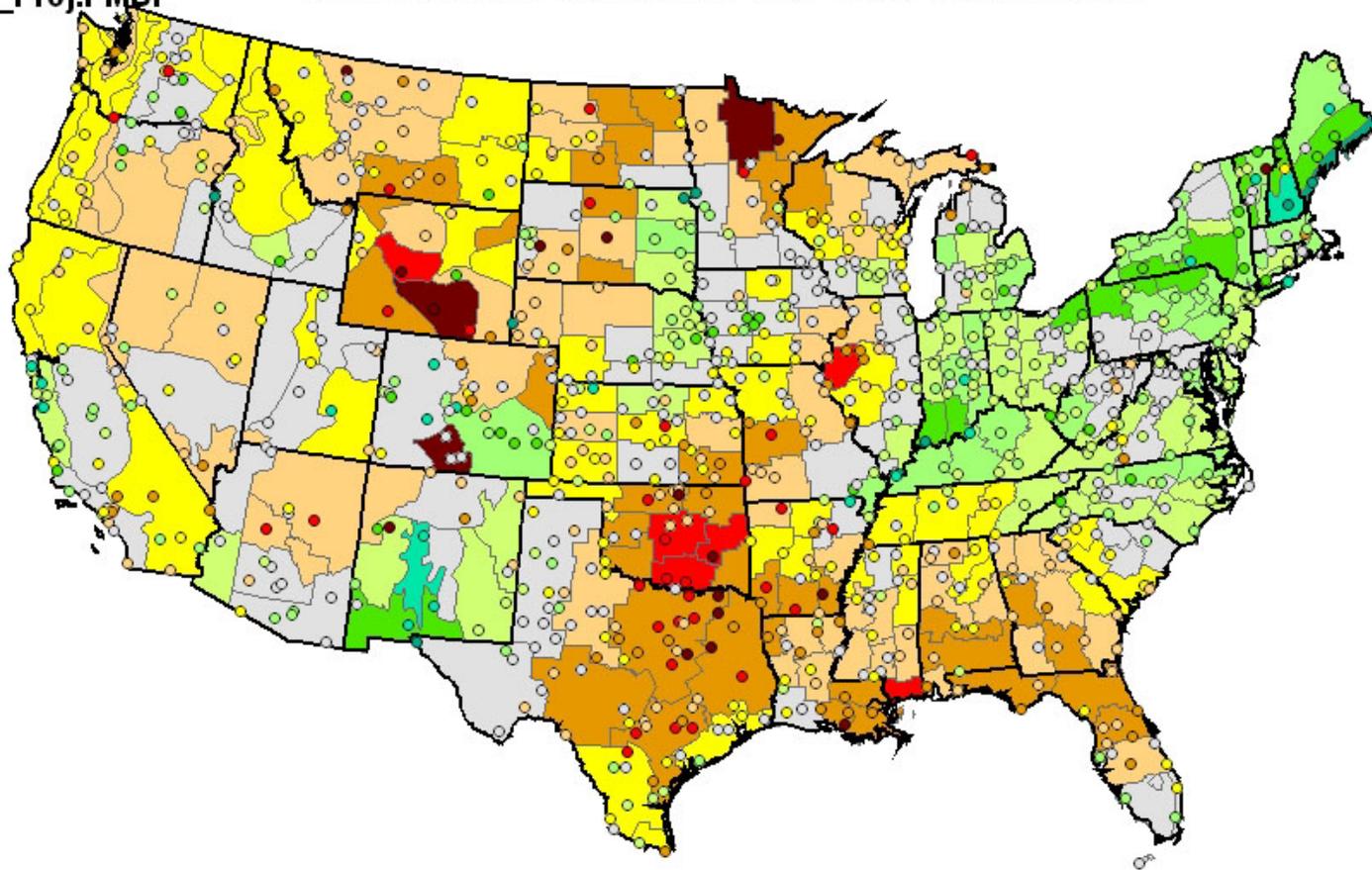
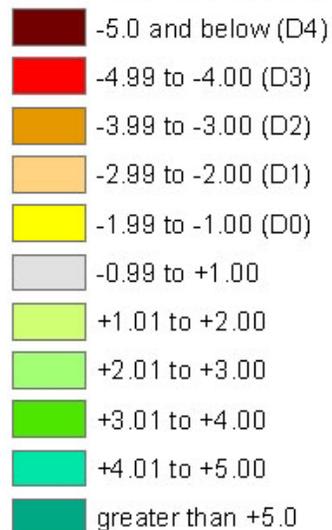
Palmer Drought Index

climdivCONUS

ALBERpminindexscurus-div-dat_Proj.PMDI

September 2006 Drought Conditions

Climate Divisions vs. 837 Stations



Comparison of the station PDI to the climate division PDI.



National Climatic Data Center



How Do the Station and Climate Division PDI Compare if they are Contoured?



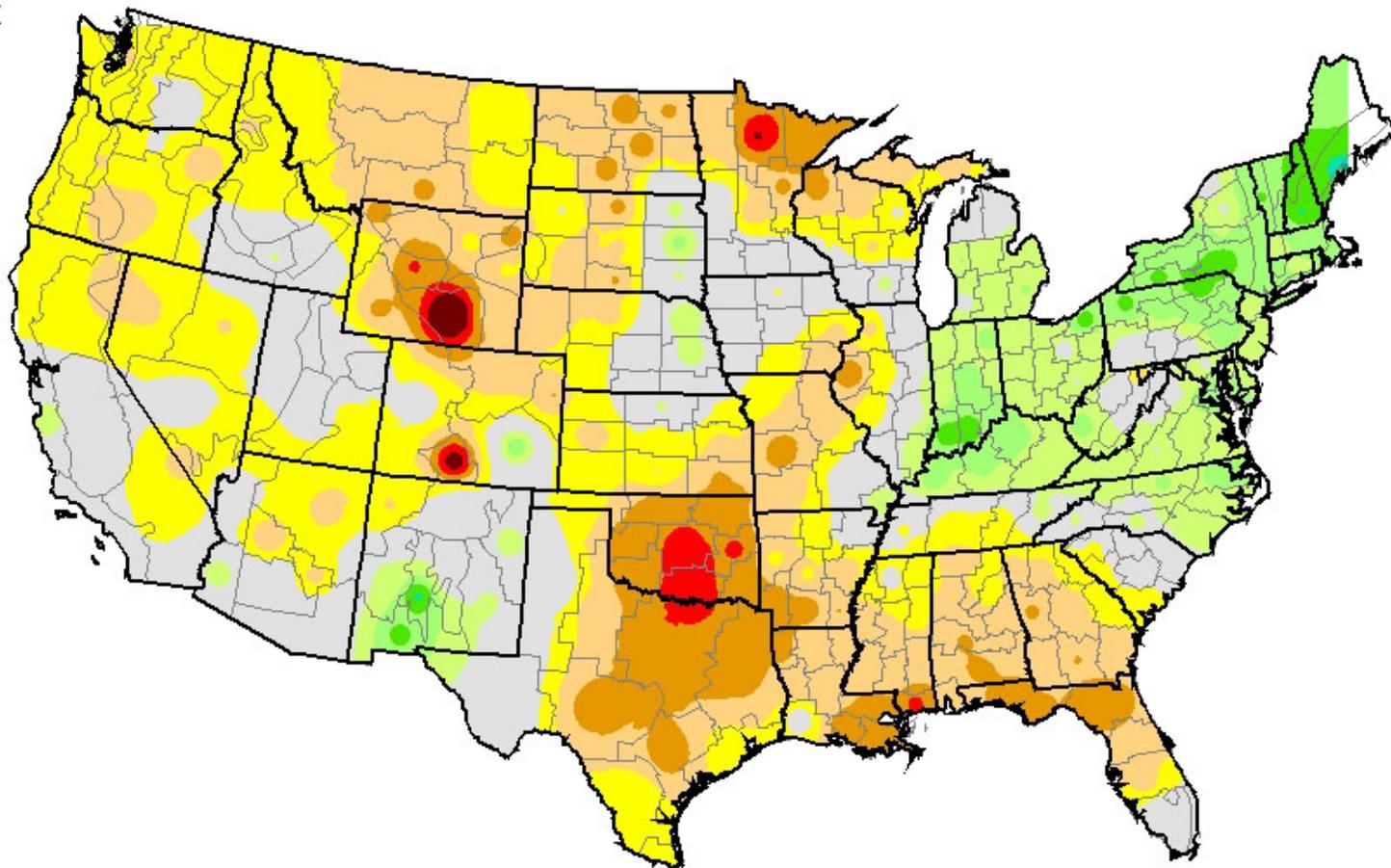
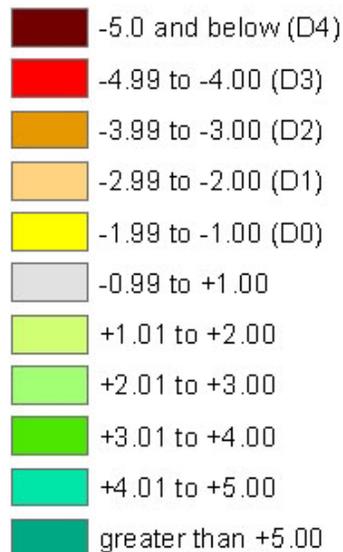
How Do the Station and Climate Division PDI Compare if they are Contoured?

September 2006 Drought Conditions Contours Based on 344 Climate Divisions

Palmer Drought Index

Idw_divPMDI

<VALUE>



Climate Division PDI Contoured



National Climatic Data Center



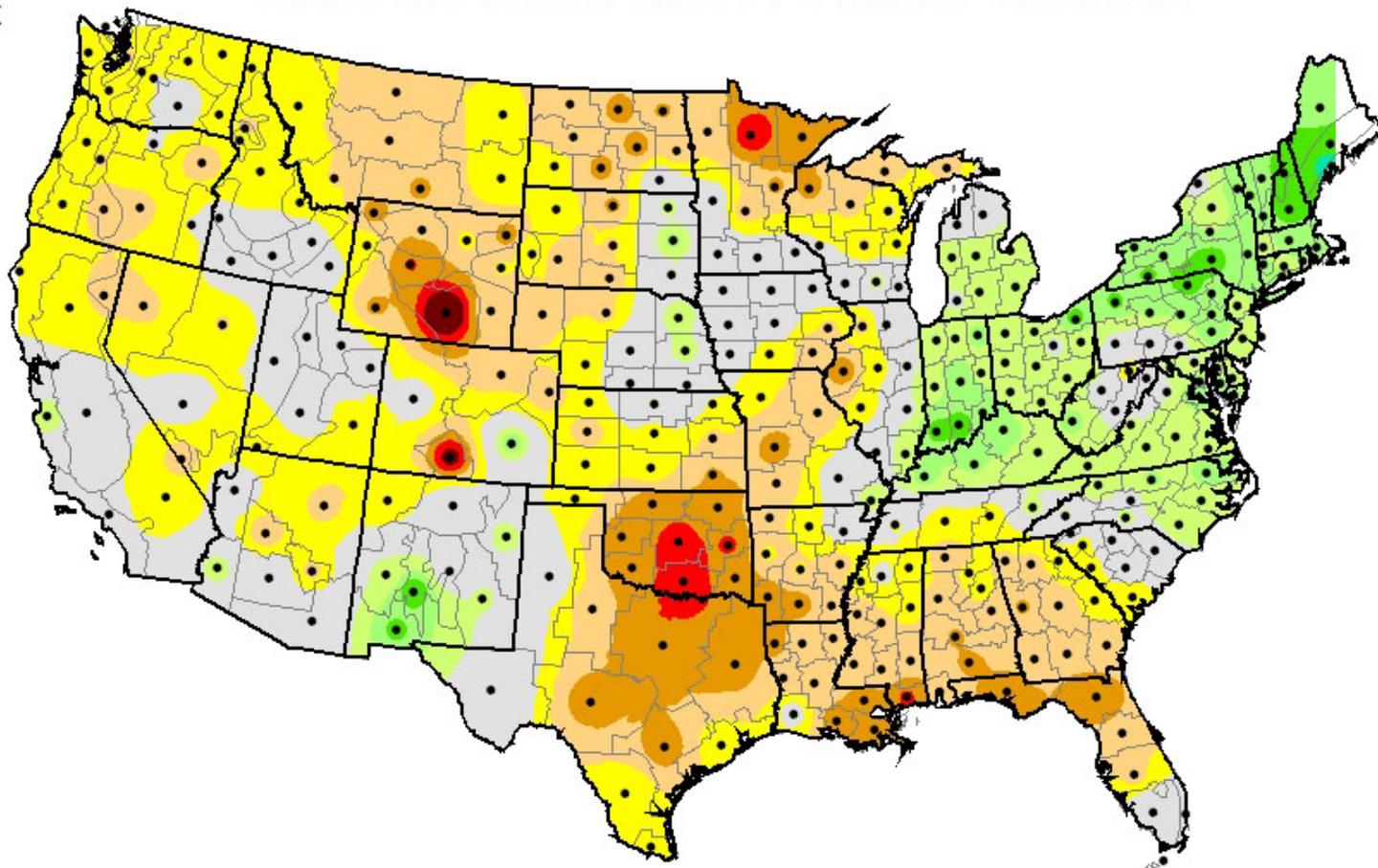
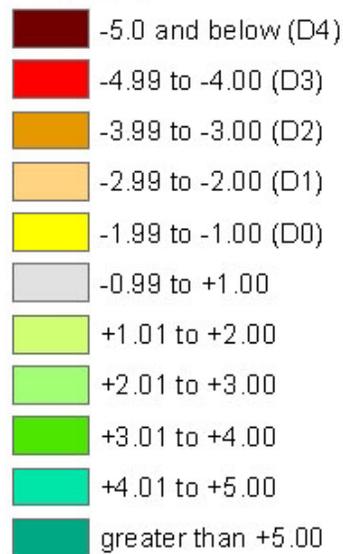
How Do the Station and Climate Division PDI Compare if they are Contoured?

September 2006 Drought Conditions Contours Based on 344 Climate Divisions

Palmer Drought Index

ldw_divPMDI

<VALUE>



Climate Division PDI Contoured, with division center-points plotted



National Climatic Data Center



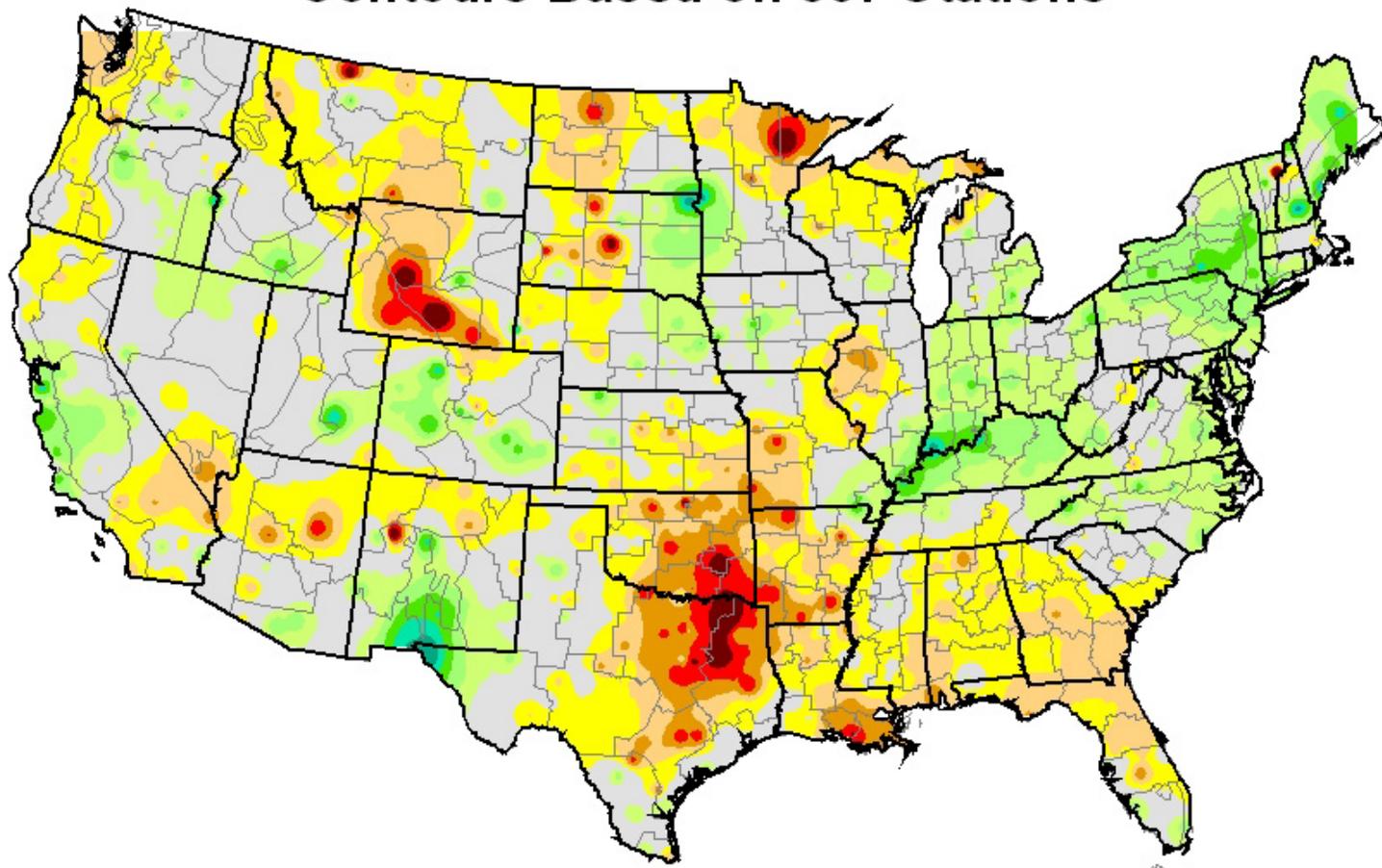
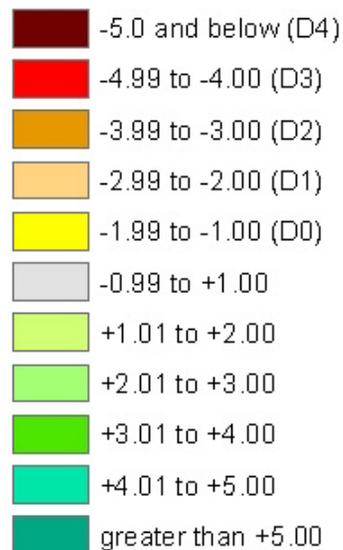
How Do the Station and Climate Division PDI Compare if they are Contoured?

September 2006 Drought Conditions Contours Based on 837 Stations

Palmer Drought Index

Idw_PMDIstn

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Station PDI Contoured



National Climatic Data Center



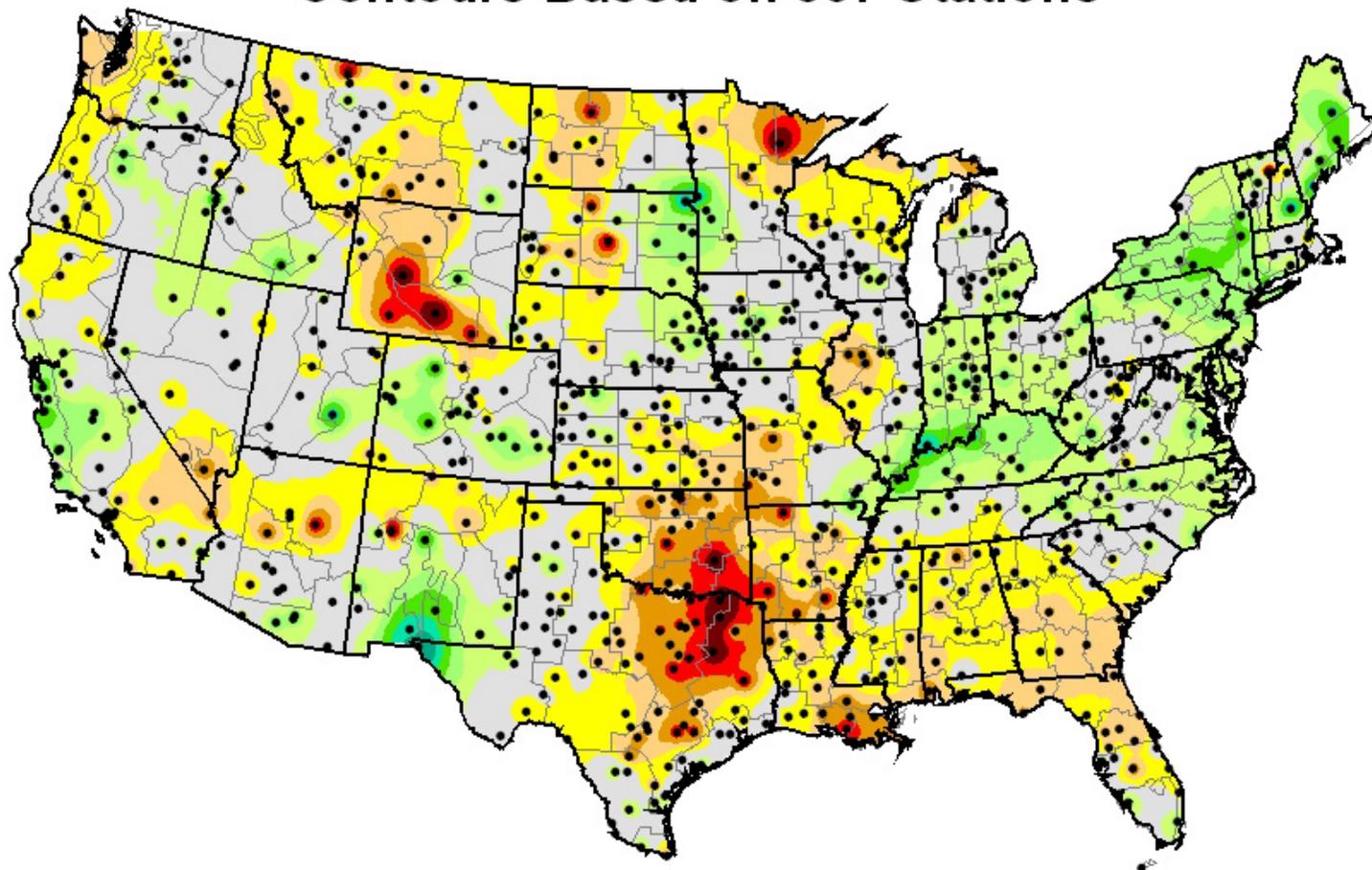
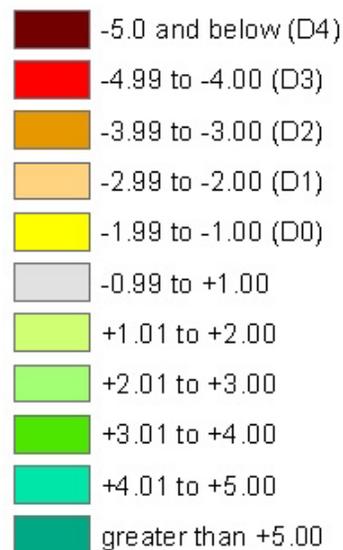
How Do the Station and Climate Division PDI Compare if they are Contoured?

September 2006 Drought Conditions Contours Based on 837 Stations

Palmer Drought Index

Idw_PMDIstn

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Station PDI Contoured, with station locations plotted



National Climatic Data Center

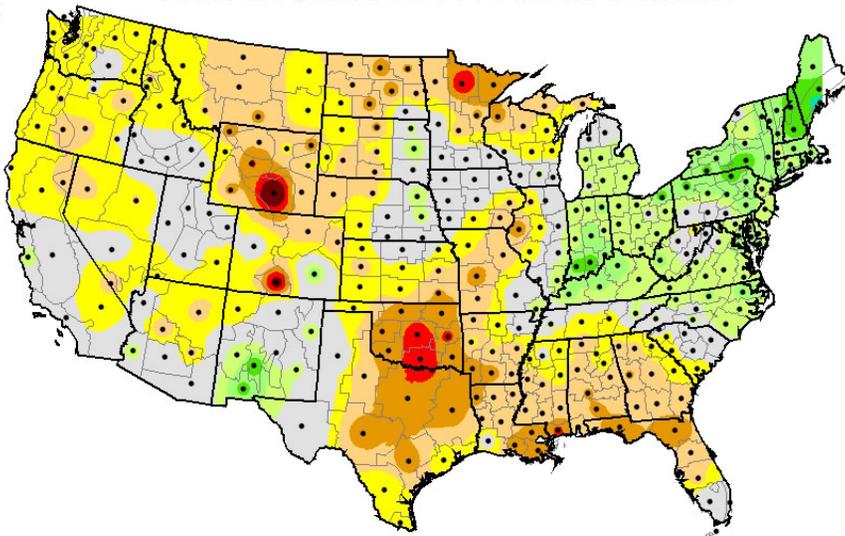
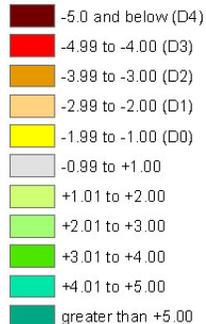


September 2006 Drought Conditions Contours Based on 344 Climate Divisions

Palmer Drought Index

Idw_divPMDI

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**How Do the Station & Climate
Division PDI Compare
if they are Contoured?**

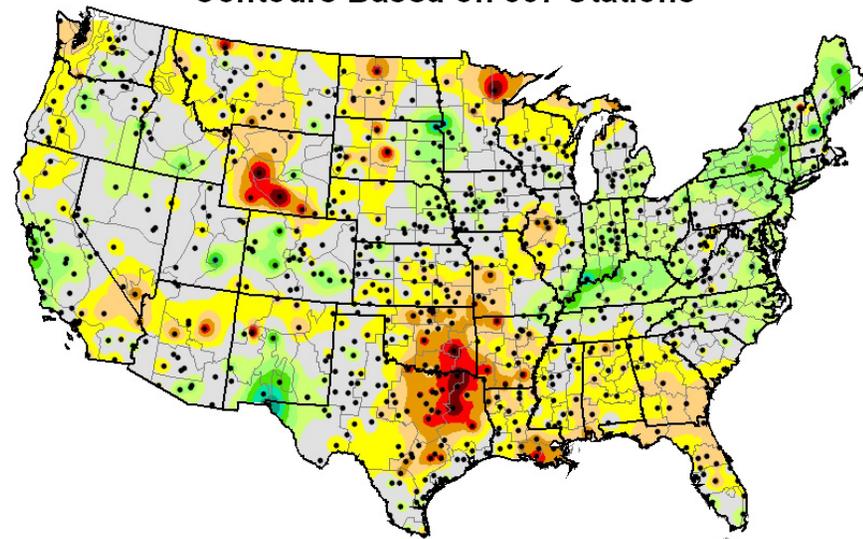
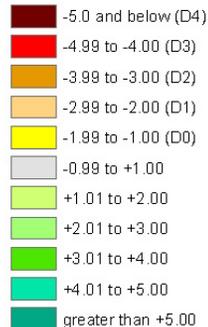
**Climate Division
PDI Contoured**

September 2006 Drought Conditions Contours Based on 837 Stations

Palmer Drought Index

Idw_PMDIstn

<VALUE>



Station PDI Contoured



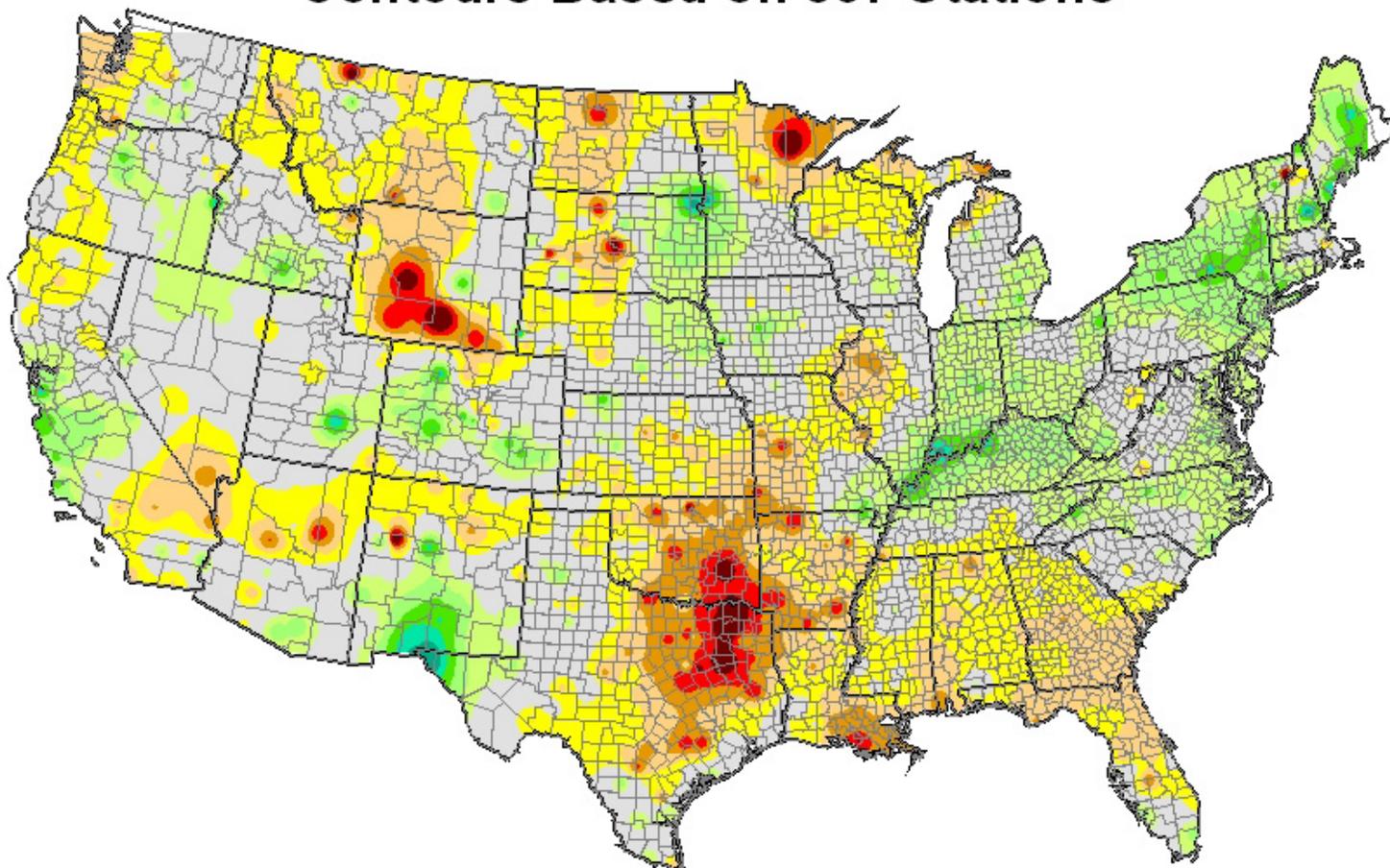
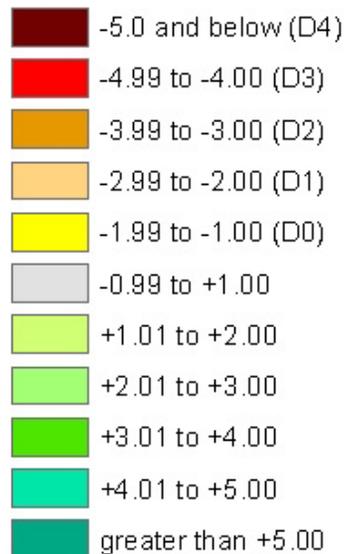
September 2006 Drought Conditions

Contours Based on 837 Stations

Palmer Drought Index

Idw_PMDIstn

<VALUE>



**Contoured Station PDI with State and County boundaries.
Station data is better for county resolution than Climate Division data.**

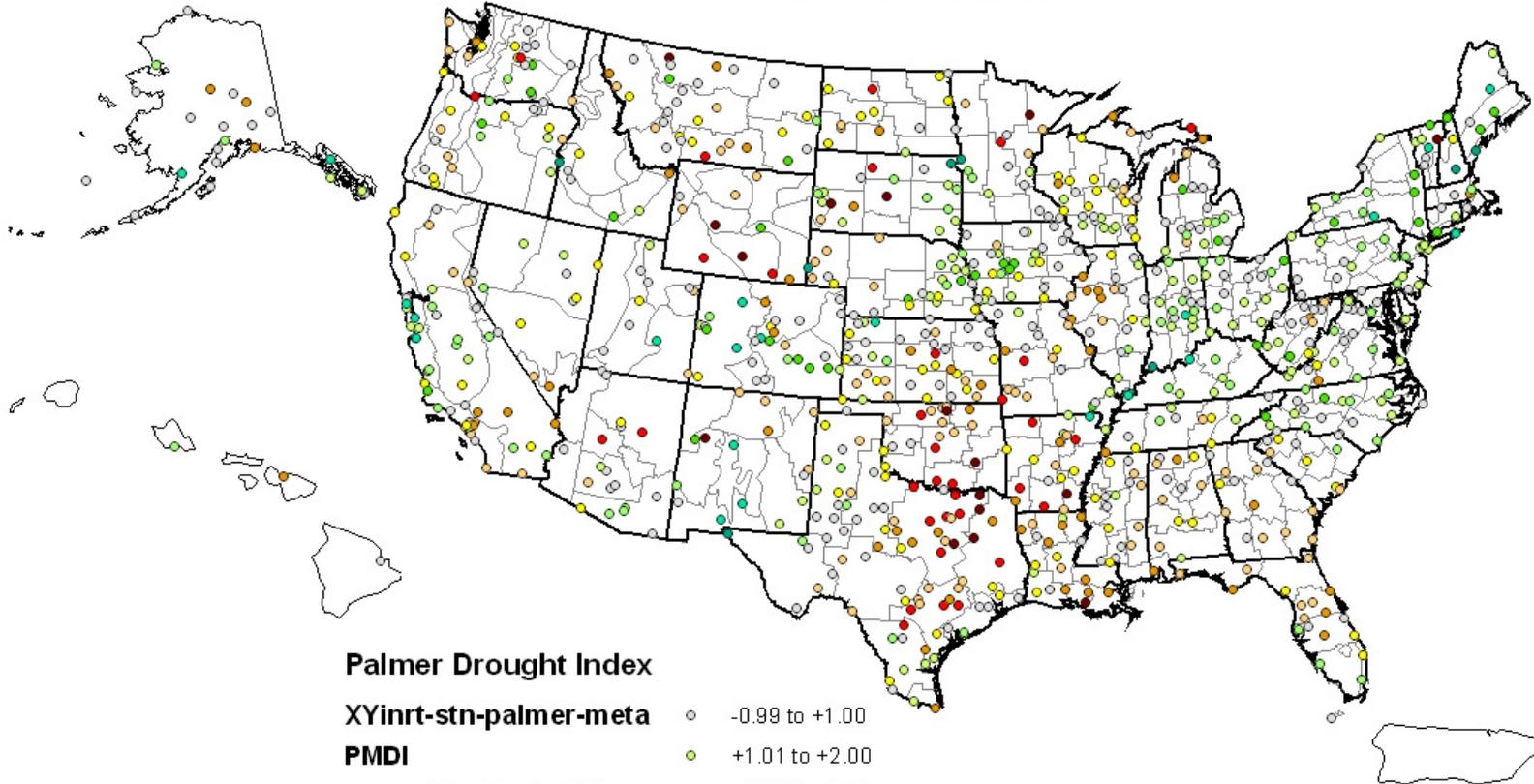


National Climatic Data Center



How Do the Station PDI Compare to the US Drought Monitor?

September 2006 Drought Conditions 863 Stations



Palmer Drought Index

XYInrt-stn-palmer-meta

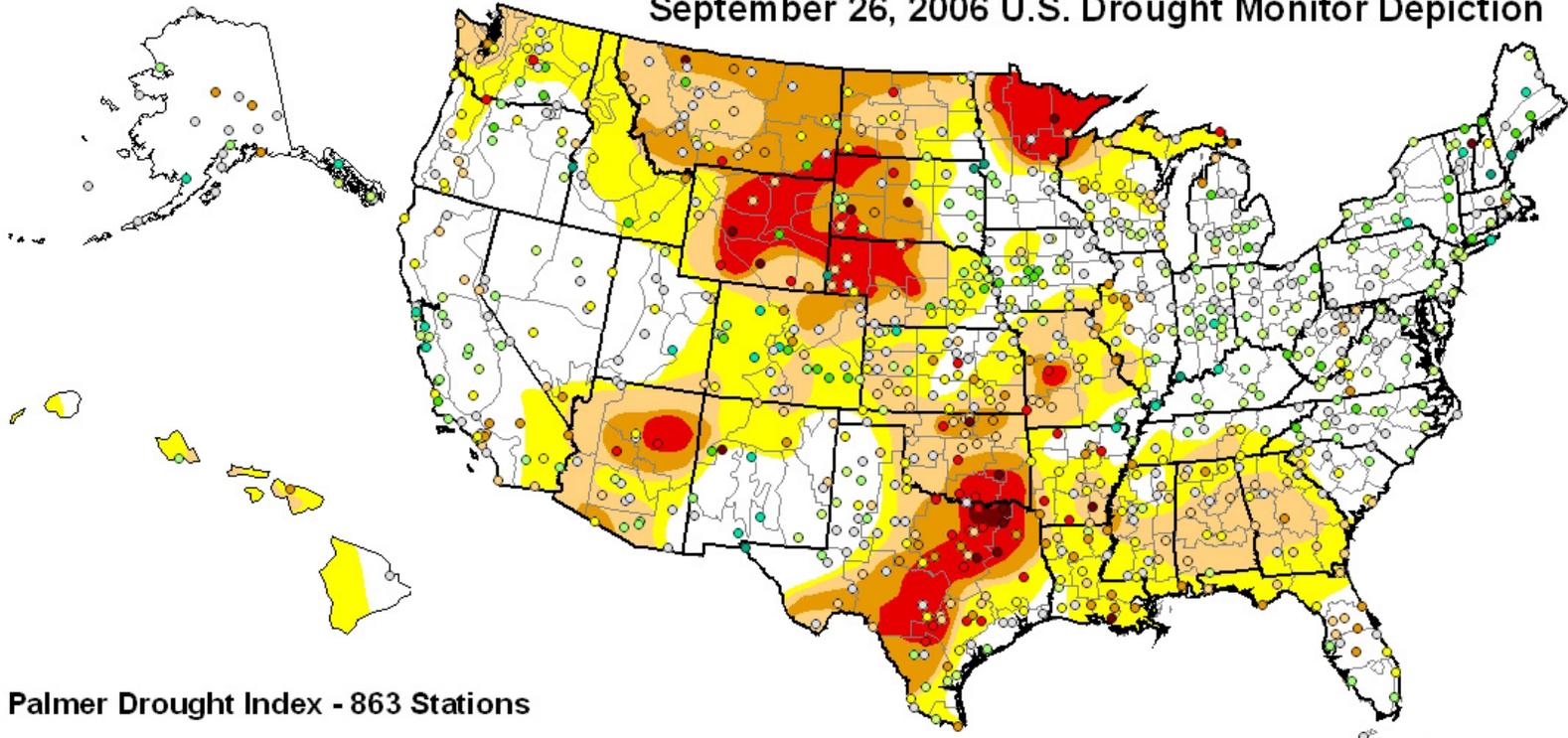
PMDI

- | | | | |
|---|---------------------|---|--------------------|
| ○ | -0.99 to +1.00 | ○ | -0.99 to +1.00 |
| ● | +1.01 to +2.00 | ● | +1.01 to +2.00 |
| ● | +2.01 to +3.00 | ● | +2.01 to +3.00 |
| ● | +3.01 to +4.00 | ● | +3.01 to +4.00 |
| ● | +4.01 to +5.00 | ● | +4.01 to +5.00 |
| ● | greater than +5.00 | ● | greater than +5.00 |
| ● | -5.0 and below (D4) | | |
| ● | -4.99 to -4.00 (D3) | | |
| ● | -3.99 to -3.00 (D2) | | |
| ● | -2.99 to -2.00 (D1) | | |
| ● | -1.99 to -1.00 (D0) | | |

How Do the Station PDI Compare to the US Drought Monitor?

September 2006 Drought Conditions

Palmer Drought Index for 863 Stations
September 26, 2006 U.S. Drought Monitor Depiction



Palmer Drought Index - 863 Stations

XYinrt-stn-palmer-meta	○	-0.99 to +1.00
PMDI	●	+1.01 to +2.00
●	●	+2.01 to +3.00
●	●	+3.01 to +4.00
●	●	+4.01 to +5.00
●	●	greater than +5.00
●		-5.0 and below (D4)
●		-4.99 to -4.00 (D3)
●		-3.99 to -3.00 (D2)
●		-2.99 to -2.00 (D1)
●		-1.99 to -1.00 (D0)

USDM September 26, 2006

Intensity:

■	D0 Abnormally Dry
■	D1 Drought - Moderate
■	D2 Drought - Severe
■	D3 Drought - Extreme
■	D4 Drought - Exceptional

Drought Impact Types:

~	Delineates dominant impacts
A	Agricultural (crops, pastures, grasslands)
H	Hydrological (water)

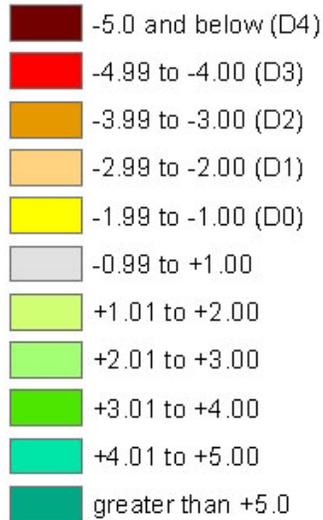


How Do the Station PDI Compare to the Climate Division PDI throughout the Historical Record?

Palmer Drought Index

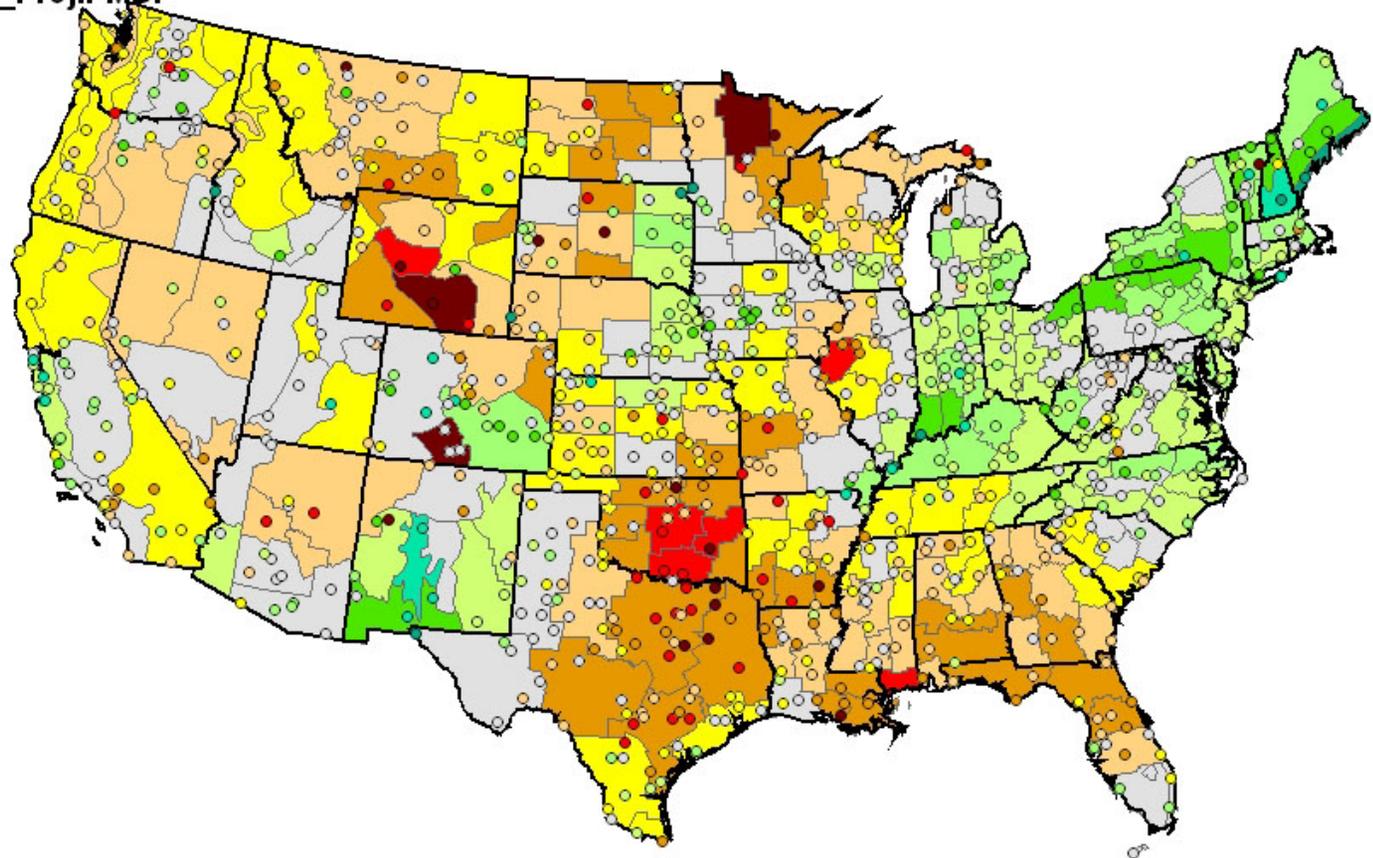
climdivCONUS

ALBERpmindexscurus-div-dat_Proj.PMDI

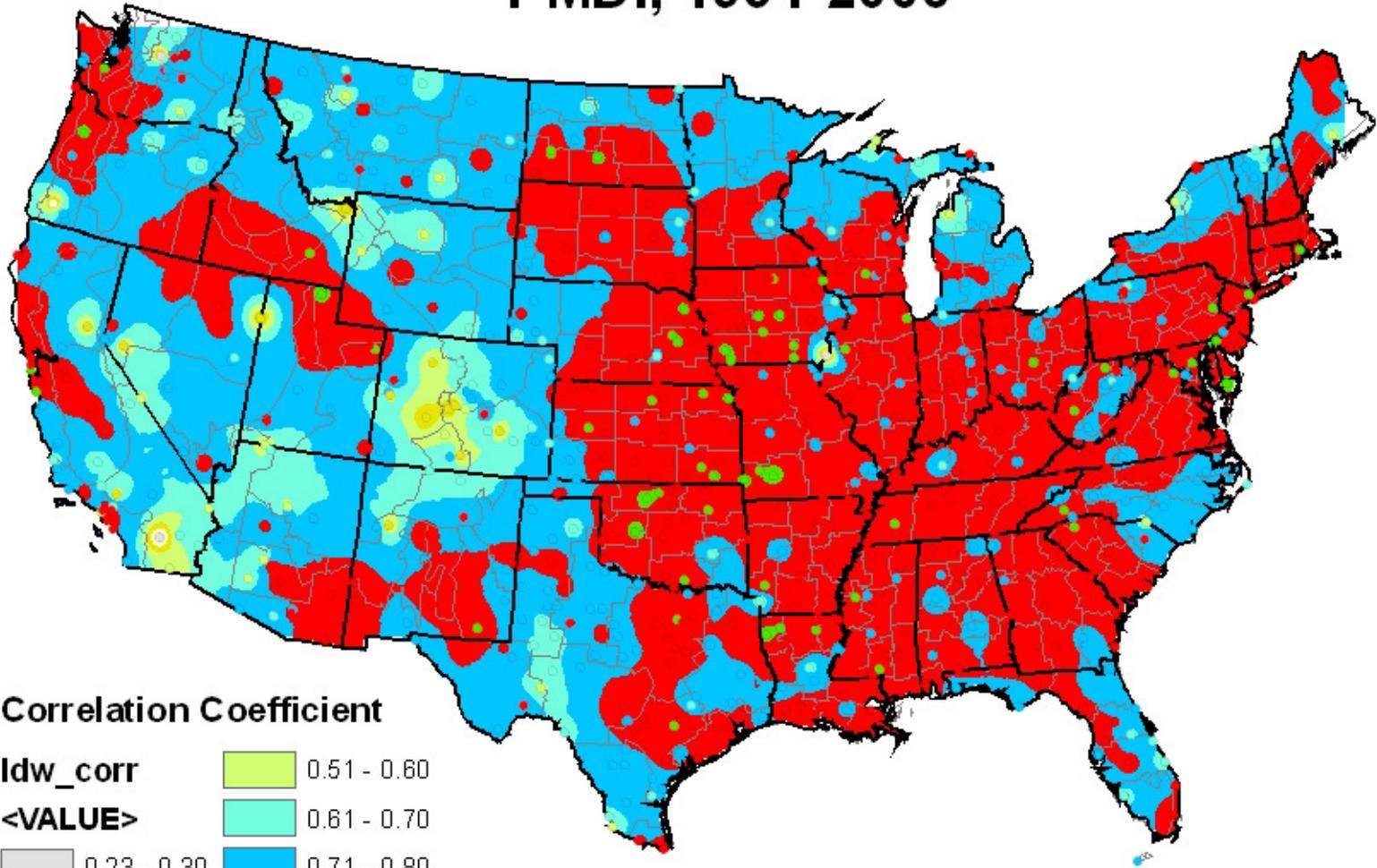


September 2006 Drought Conditions

Climate Divisions vs. 837 Stations



Station vs. Climate Division Correlations PMDI, 1951-2006



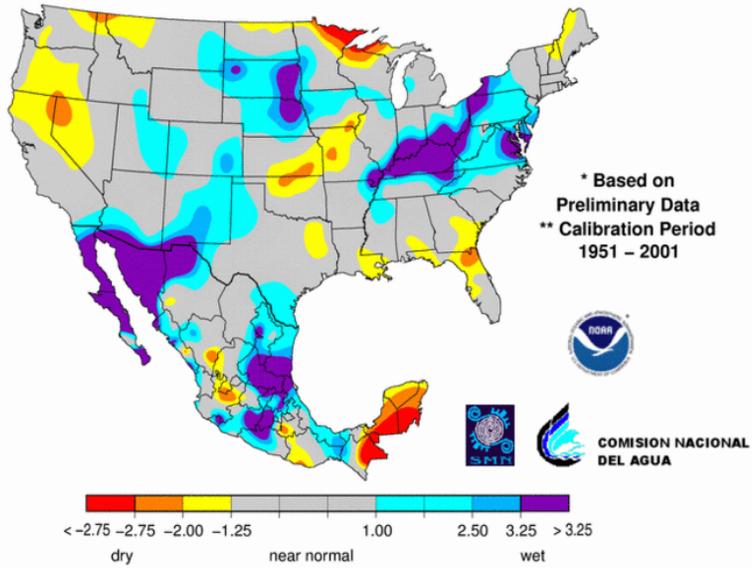
Correlation Coefficient

ldw_corr	0.51 - 0.60
<VALUE>	0.61 - 0.70
0.23 - 0.30	0.71 - 0.80
0.31 - 0.40	0.81 - 0.90
0.41 - 0.50	0.91 - 0.95

How Do the US-MX Contoured NADM Indicator Maps Compare: U.S. Climate Divisions vs. U.S. Stations?



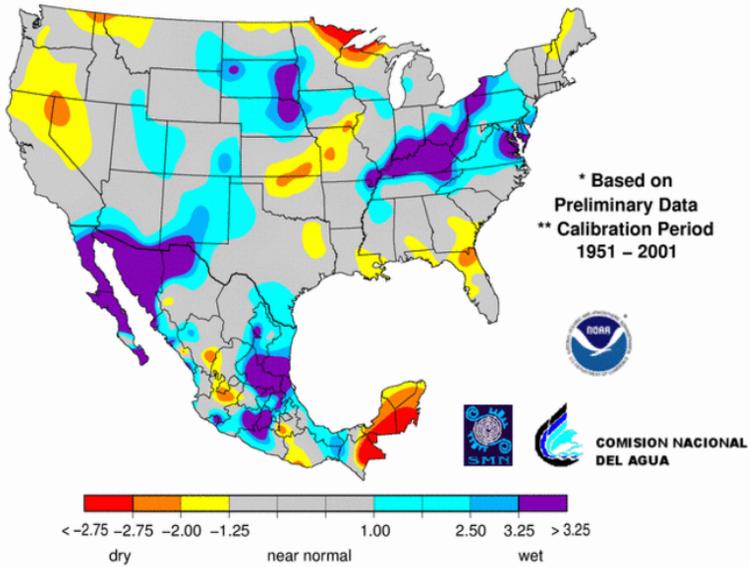
Palmer Z-Index September 2006



U.S. Climate Divisions



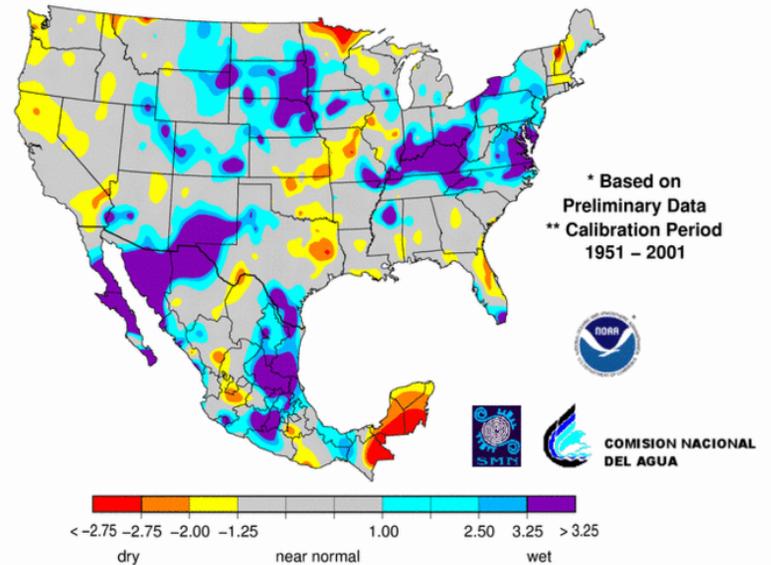
Palmer Z-Index September 2006



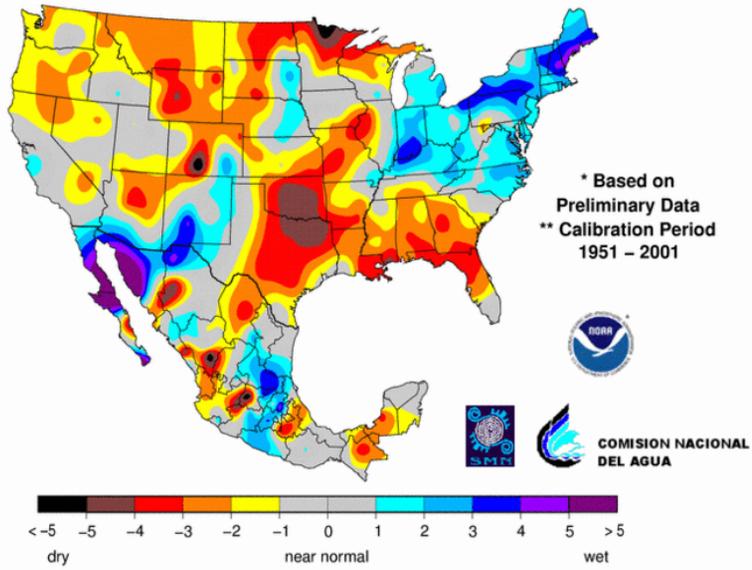
U.S. Climate Divisions

U.S. Stations

Palmer Z-Index September 2006



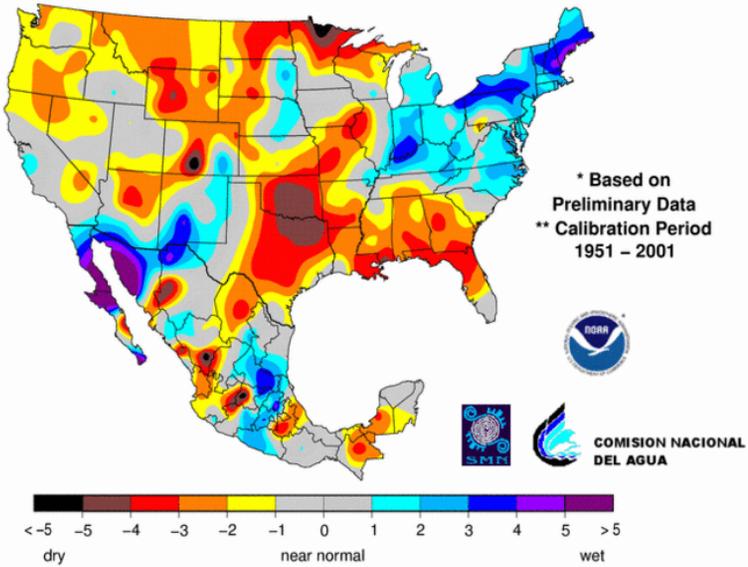
Palmer Drought Index September 2006



U.S. Climate Divisions



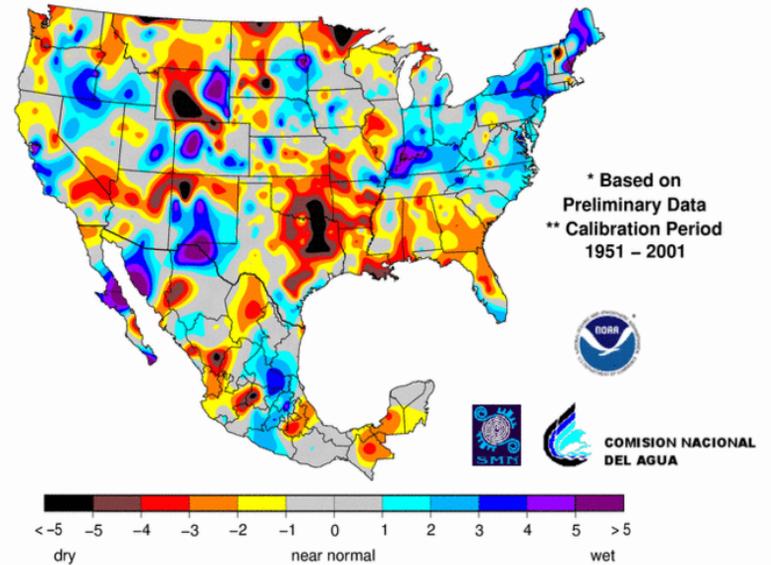
**Palmer Drought Index
September 2006**



U.S. Climate Divisions

U.S. Stations

**Palmer Drought Index
September 2006**



Using Station Data – Strengths and Weaknesses

✓ Strengths:

- Point measurements
- Fine spatial resolution

✓ But stations suffer from missing data, & different periods of record.

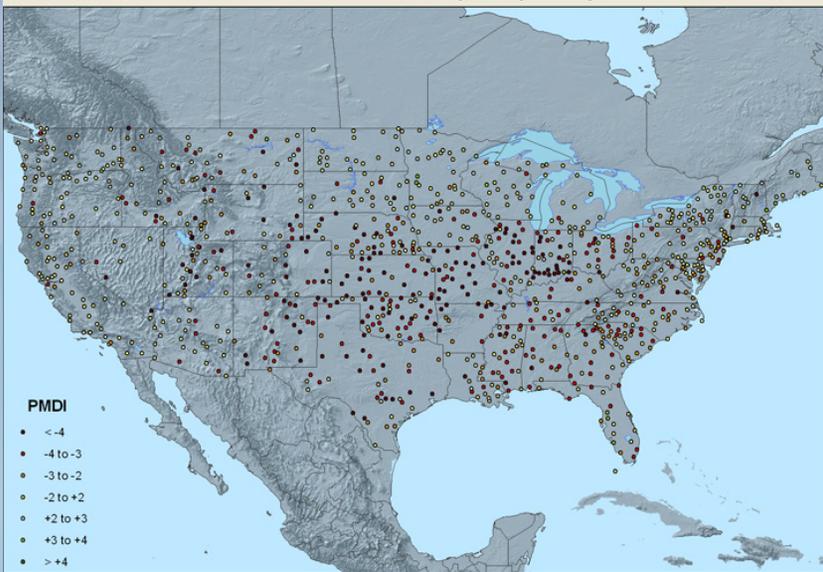
✓ Also, contours based on station data will be different depending on which stations are used, and on the number of stations used.

✓ The Solution?

- Using a gridded dataset, we can take care of the missing data and consistent period of record issues.
- Use a consistent station data base historically to create the gridded dataset.

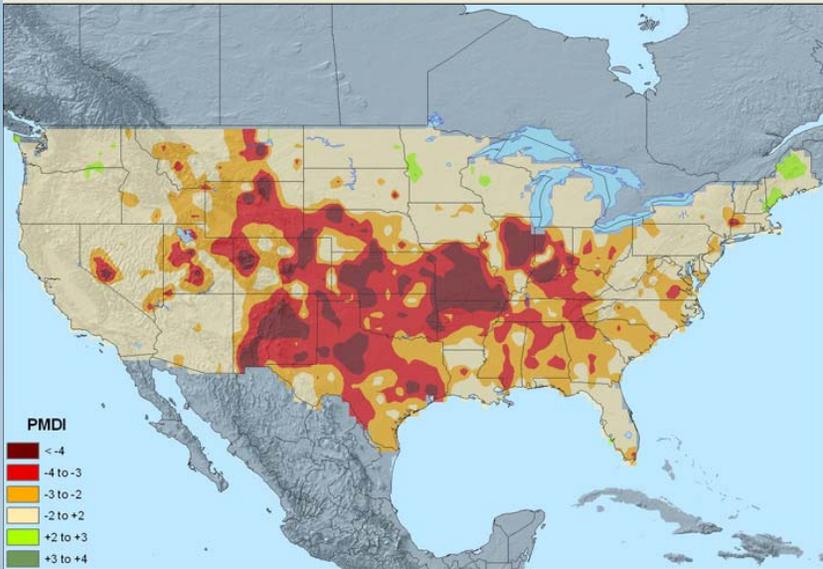


PMDI at Stations (1037) - July, 1954

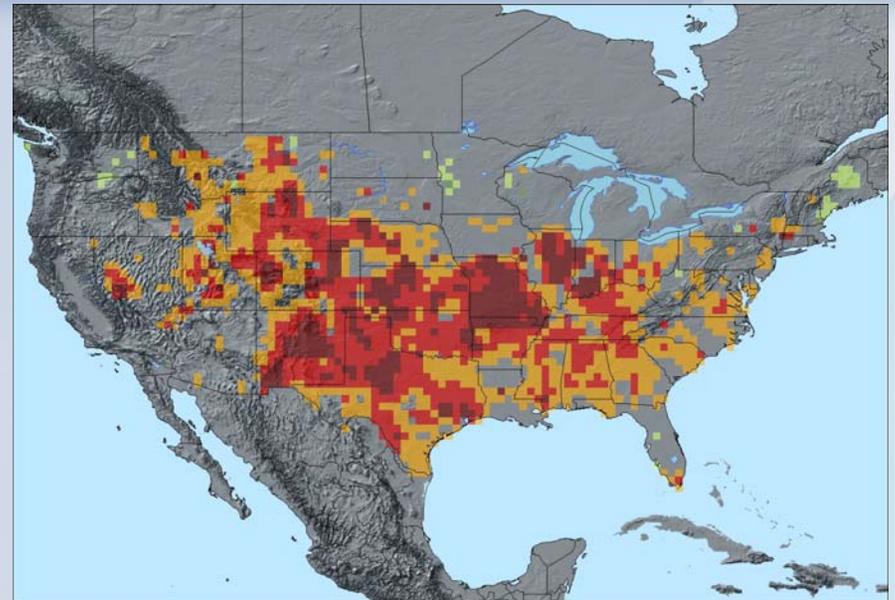


- PMDI
- <-4
 - -4 to -3
 - -3 to -2
 - -2 to +2
 - +2 to +3
 - +3 to +4
 - >+4

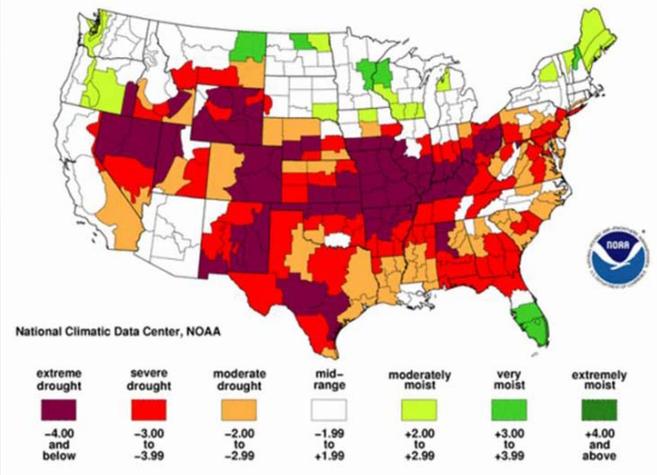
PMDI Grid - July, 1954



- PMDI
- <-4
 - -4 to -3
 - -3 to -2
 - -2 to +2
 - +2 to +3
 - +3 to +4



Palmer Modified Drought Index
July, 1954



Grids (.5x.5 degree) created from July 1954 station data.

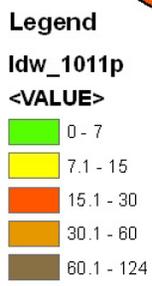
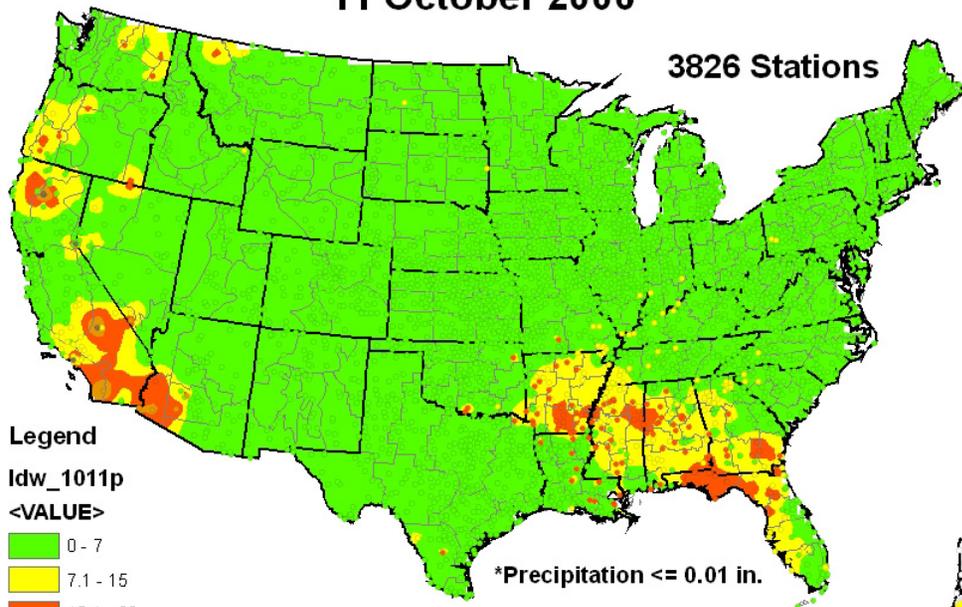


National Climatic Data Center



Number of Consecutive Days with No Precipitation* 11 October 2006

3826 Stations

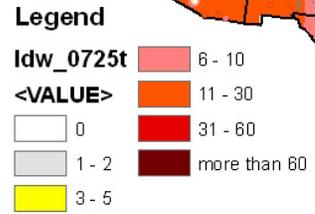
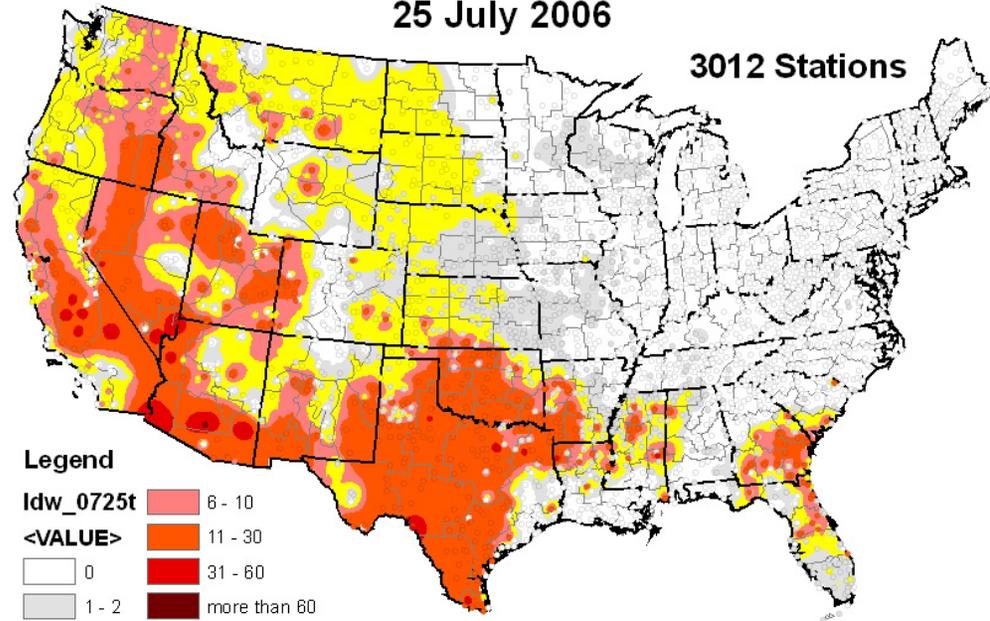


*Precipitation \leq 0.01 in.

Additional drought indicators that can be created from daily station data include Number of Consecutive Days indices.

Number of Consecutive Days with Max Temperature \geq 90 F (32.2 C) 25 July 2006

3012 Stations



**North America Drought Monitor web page:
<http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html>**

Gracias!

Richard.Heim@noaa.gov



National Climatic Data Center

